

#### SCOPE OF CLAIMS

1. An apparatus for controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising:

means for sequentially acquiring element temperature data representing the temperature of said active element, means for sequentially acquiring heater temperature data representing the temperature of said heater, and heater control means for sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the active element represented by said element temperature data to a predetermined target temperature, and controlling the heater depending on the control input, and characterized in that said control input generated by said heater control means includes at least an input component depending on the difference between the temperature of the active element represented by said element temperature data and said target temperature and an input component depending on the temperature of the heater represented by said heater temperature data.

2. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 1, character-

ized by comprising means for sequentially acquiring exhaust gas temperature data representing the temperature of said exhaust gas, and characterized in that said control input generated by said heater control means includes an input component depending on the temperature of the exhaust gas represented by said exhaust gas temperature data.

3. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 1, characterized in that said control input generated by said heater control means includes an input component depending on said target temperature.

4. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 1, characterized in that said control input generated by said heater control means includes an input component depending on the temperature of the active element represented by said element temperature data.

5. An apparatus for controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising:

means for sequentially acquiring element temperature data representing the temperature of said active element, means for sequentially acquiring exhaust gas tem-

perature data representing the temperature of said exhaust gas, and heater control means for sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the active element represented by said element temperature data to a predetermined target temperature, and controlling the heater depending on the control input, and characterized in that said control input generated by said heater control means includes at least an input component depending on the difference between the temperature of the active element represented by said element temperature data and said target temperature and an input component depending on the temperature of the exhaust gas represented by said exhaust gas temperature data.

6. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 5, characterized in that said control input generated by said heater control means includes an input component depending on said target temperature.

7. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 5, characterized in that said control input generated by said heater control means includes an input component depending on the temperature of the active element represented by said element temperature data.

8. An apparatus for controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising:

means for sequentially acquiring element temperature data representing the temperature of said active element, and heater control means for sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the active element represented by said element temperature data to a predetermined target temperature, and controlling the heater depending on the control input, and characterized in that said control input generated by said heater control means includes at least an input component depending on the difference between the temperature of the active element represented by said element temperature data and said target temperature and an input component depending on said target temperature.

9. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 8, characterized in that said control input generated by said heater control means includes an input component depending on the temperature of the active element represented by said element temperature data.

10. An apparatus for controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising:

means for sequentially acquiring element temperature data representing the temperature of said active element, and heater control means for sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the active element represented by said element temperature data to a predetermined target temperature, and controlling the heater depending on the control input, and characterized in that said control input generated by said heater control means includes at least an input component depending on the difference between the temperature of the active element represented by said element temperature data and said target temperature and an input component depending on the temperature of the active element.

11. An apparatus for controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust

passage and a heater for heating the active element, characterized by comprising:

means for sequentially acquiring element temperature data representing the temperature of said active element, means for sequentially acquiring heater temperature data representing the temperature of said heater, means for sequentially acquiring exhaust gas temperature data representing the temperature of said exhaust gas, and heater control means for sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the active element represented by said element temperature data to a predetermined target temperature, and controlling the heater depending on the control input, and characterized in that said control input generated by said heater control means includes at least an input component depending on the difference between the temperature of the active element represented by said element temperature data and said target temperature, an input component depending on the temperature of the heater represented by said heater temperature data, an input component depending on the temperature of the exhaust gas represented by said exhaust gas temperature data, and an input component depending on said target temperature.

12. An apparatus for controlling the temperature of an exhaust gas sensor according to any one of claims 2,

5 through 7, and 11, characterized in that the input component depending on the temperature of said exhaust gas, in the control input sequentially generated by said heater control means, comprises an input component depending on time-series data of the temperature of the exhaust gas including a present value of the temperature of the exhaust gas and a future value of the temperature of the exhaust gas after a first predetermined time, and said heater control means generates said control input including said input component according to a predictive control algorithm.

13. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 12, characterized in that said heater control means generates said control input by determining the future value of the temperature of the exhaust gas until after the first predetermined time as being equal to the present value of the temperature of the exhaust gas.

14. An apparatus for controlling the temperature of an exhaust gas sensor according to any one of claims 3, 6, 8, 9, and 11, characterized in that the input component depending on said target temperature which is sequentially generated by said heater control means comprises an input component depending on time-series data of the target temperature including a present value of the target temperature and a future value of the target temperature after a second predetermined time, and said heater control means

generates said control input including said input component according to a predictive control algorithm.

15. An apparatus for controlling the temperature of an exhaust gas sensor according to any one of claims 1 through 11, characterized in that said heater control means generates said control input according to an optimum control algorithm.

16. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 12, characterized in that said heater control means generates said control input according to an optimum predictive control algorithm.

17. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 14, characterized in that said heater control means generates said control input according to an optimum predictive control algorithm.

18. An apparatus for controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising:

means for sequentially acquiring element temperature data representing the temperature of said active element, means for sequentially acquiring heater tempera-



ture data representing the temperature of said heater, and heater control means for sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the heater represented by said heater temperature data to a predetermined target temperature, and controlling the heater depending on the control input, characterized in that said control input generated by said heater control means includes at least an input component depending on the difference between the temperature of the heater represented by said heater temperature data and said target temperature, and an input component depending on the temperature of the active element represented by said element temperature data.

19. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 18, characterized by comprising means for sequentially acquiring exhaust gas temperature data representing the temperature of said exhaust gas, and characterized in that said control input generated by said heater control means includes an input component depending on the temperature of the exhaust gas represented by said exhaust gas temperature data.

20. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 18, characterized in that said control input generated by said heater

control means includes an input component depending on said target temperature.

21. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 18, characterized in that said control input generated by said heater control means includes an input component depending on the temperature of the heater represented by said heater temperature data.

22. An apparatus for controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising:

means for sequentially acquiring heater temperature data representing the temperature of said heater, means for sequentially acquiring exhaust gas temperature data representing the temperature of said exhaust gas, and heater control means for sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the heater represented by said heater temperature data to a predetermined target temperature, and controlling the heater depending on the control input, and characterized in that said control input generated by said heater control means includes at least an input component depending on the

difference between the temperature of the heater represented by said heater temperature data and said target temperature, and an input component depending on the temperature of the temperature of the exhaust gas represented by said exhaust gas temperature data.

23. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 22, characterized in that said control input generated by said heater control means includes an input component depending on said target temperature.

24. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 22, characterized in that said control input generated by said heater control means includes an input component depending on the temperature of the heater represented by said heater temperature data.

25. An apparatus for controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising:

means for sequentially acquiring heater temperature data representing the temperature of said heater, and heater control means for sequentially generating a control input which defines an amount of heat generating energy

supplied to said heater so as to equalize the temperature of the heater represented by said heater temperature data to a predetermined target temperature, and controlling the heater depending on the control input, and characterized in that said control input generated by said heater control means includes at least an input component depending on the difference between the temperature of the heater represented by said heater temperature data and said target temperature and an input component depending on said target temperature.

26. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 25, characterized in that said control input generated by said heater control means includes an input component depending on the temperature of the heater represented by said heater temperature data.

27. An apparatus for controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising:

means for sequentially acquiring heater temperature data representing the temperature of said heater, and heater control means for sequentially generating a control input which defines an amount of heat generating energy

supplied to said heater so as to equalize the temperature of the heater represented by said heater temperature data to a predetermined target temperature, and controlling the heater depending on the control input, and characterized in that said control input generated by said heater control means includes at least an input component depending on the difference between the temperature of the heater represented by said heater temperature data and said target temperature and an input component depending on the temperature of said heater.

28. An apparatus for controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising:

means for sequentially acquiring element temperature data representing the temperature of said active element, means for sequentially acquiring heater temperature data representing the temperature of said heater, means for sequentially acquiring exhaust gas temperature data representing the temperature of said exhaust gas, and heater control means for sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the heater represented by said heater temperature data

to a predetermined target temperature, and controlling the heater depending on the control input, and characterized in that said control input generated by said heater control means includes at least at least an input component depending on the difference between the temperature of the heater represented by said heater temperature data and said target temperature, an input component depending on the temperature of the active element represented by said element temperature data, an input component depending on the temperature of the exhaust gas represented by said exhaust gas temperature data, and an input component depending on said target temperature.

29. An apparatus for controlling the temperature of an exhaust gas sensor according to any one of claims 19, 22 through 24, and 28, characterized in that the input component depending on the temperature of said exhaust gas, in the control input sequentially generated by said heater control means, comprises an input component depending on time-series data of the temperature of the exhaust gas including a present value of the temperature of the exhaust gas and a future value of the temperature of the exhaust gas after a first predetermined time, and said heater control means generates said control input including said input component according to a predictive control algorithm.

30. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 29, character-

ized in that said heater control means generates said control input by determining the future value of the temperature of the exhaust gas until after the first predetermined time as being equal to the present value of the temperature of the exhaust gas.

31. An apparatus for controlling the temperature of an exhaust gas sensor according to any one of claims 20, 23, 25, 26, and 28, characterized in that the input component depending on said target temperature which is sequentially generated by said heater control means comprises an input component depending on time-series data of the target temperature including a present value of the target temperature and a future value of the target temperature after a second predetermined time, and said heater control means generates said control input including said input component according to a predictive control algorithm.

32. An apparatus for controlling the temperature of an exhaust gas sensor according to any one of claims 18 through 28, characterized in that said heater control means generates said control input according to an optimum control algorithm.

33. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 29, characterized in that said heater control means generates said control input according to an optimum predictive control algorithm.

34. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 31, characterized in that said heater control means generates said control input according to an optimum predictive control algorithm.

35. An apparatus for controlling the temperature of an exhaust gas sensor according to any one of claims 1, 5, 8, 10, 11, 18, 22, 25, 27, and 28, characterized in that said target temperature in a period immediately after said internal combustion engine has started to operate until a third predetermined time elapses is set to a temperature which is lower than said target temperature after elapse of said period immediately after said internal combustion engine has started to operate.

36. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 14, characterized in that said target temperature in a period immediately after said internal combustion engine has started to operate until a third predetermined time elapses is set to a temperature which is lower than said target temperature after elapse of said period immediately after said internal combustion engine has started to operate.

37. An apparatus for controlling the temperature of an exhaust gas sensor according to claim 31, characterized in that said target temperature in a period immediately after said internal combustion engine has started to



operate until a third predetermined time elapses is set to a temperature which is lower than said target temperature after elapse of said period immediately after said internal combustion engine has started to operate.

38. An apparatus for controlling the temperature of an exhaust gas sensor according to any one of claims 1, 5, 8, 10, 11, 18, 22, 25, 27, and 28, characterized in that said heater comprises an electric heater for generating heat when energized by a battery according to a pulse width control (PWM control) process, and the control input generated by said heater control means comprises a duty cycle in said pulse width control process, further characterized by comprising means for correcting said duty cycle depending on the voltage of said battery.

39. A method of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising the steps of:

sequentially acquiring element temperature data representing the temperature of said active element and heater temperature data representing the temperature of said heater, sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the active

element represented by said element temperature data to a predetermined target temperature, and controlling the heater depending on the control input, and characterized in that when said control input is generated, said control input is generated so as to include at least an input component depending on the difference between the temperature of the active element represented by said element temperature data and said target temperature and an input component depending on the temperature of the heater represented by said heater temperature data.

40. A method of controlling the temperature of an exhaust gas sensor according to claim 39, further characterized by comprising the step of sequentially acquiring exhaust gas temperature data representing the temperature of said exhaust gas, and characterized in that when said control input is generated, said control input is generated so as to further include an input component depending on the temperature of the exhaust gas represented by said exhaust gas temperature data.

41. A method of controlling the temperature of an exhaust gas sensor according to claim 39, characterized in that when said control input is generated, said control input is generated so as to further include an input component depending on said target temperature.

42. A method of controlling the temperature of an exhaust gas sensor according to claim 39, characterized

in that when said control input is generated, said control input is generated so as to further include an input component depending on the temperature of the active element represented by said element temperature data.

43. A method of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising the steps of:

sequentially acquiring element temperature data representing the temperature of said active element and exhaust gas temperature data representing the temperature of said exhaust gas, sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the active element represented by said element temperature data to a predetermined target temperature, and controlling the heater depending on the control input, and characterized in that when said control input is generated, said control input is generated so as to include at least an input component depending on the difference between the temperature of the active element represented by said element temperature data and said target temperature and an input component depending on the temperature of the exhaust gas represented by said exhaust gas temperature data.

44. A method of controlling the temperature of an exhaust gas sensor according to claim 43, characterized in that when said control input is generated, said control input is generated so as to further include an input component depending on said target temperature.

45. A method of controlling the temperature of an exhaust gas sensor according to claim 43, characterized in that when said control input is generated, said control input is generated so as to further include an input component depending on the temperature of the active element represented by said element temperature data.

46. A method of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising the steps of:

sequentially acquiring element temperature data representing the temperature of said active element, sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the active element represented by said element temperature data to a predetermined target temperature, and controlling the heater depending on the control input, and characterized in that when said control input is generated, said control input is generated so

as to further include at least an input component depending on the difference between the temperature of the active element represented by said element temperature data and said target temperature and an input component depending on said target temperature.

47. A method of controlling the temperature of an exhaust gas sensor according to claim 46, characterized in that when said control input is generated, said control input is generated so as to further include an input component depending on the temperature of the active element represented by said element temperature data.

48. A method of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising the steps of:

sequentially acquiring element temperature data representing the temperature of said active element, sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the active element represented by said element temperature data to a predetermined target temperature, and controlling the heater depending on the control input, and characterized in that when said control input is generated, said control input is generated so

as to include at least an input component depending on the difference between the temperature of the active element represented by said element temperature data and said target temperature and an input component depending on the temperature of the active element.

49. A method of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising the steps of:

sequentially acquiring element temperature data representing the temperature of said active element, heater temperature data representing the temperature of said heater, and exhaust gas temperature data representing the temperature of said exhaust gas, sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the active element represented by said element temperature data to a predetermined target temperature, and controlling the heater depending on the control input, and characterized in that when said control input is generated, said control input is generated so as to include at least an input component depending on the difference between the temperature of the active element represented by said element temperature data and said target temperature, an input

component depending on the temperature of the heater represented by said heater temperature data, an input component depending on the temperature of the exhaust gas represented by said exhaust gas temperature data, and an input component depending on said target temperature.

50. A method of controlling the temperature of an exhaust gas sensor according to any one of claims 40, 43 through 45, and 49, characterized in that the input component depending on the temperature of said exhaust gas, included in said the control input, comprises an input component depending on time-series data of the temperature of the exhaust gas including a present value of the temperature of the exhaust gas and a future value of the temperature of the exhaust gas after a first predetermined time, and said control input including said input component is generated according to a predictive control algorithm.

51. A method of controlling the temperature of an exhaust gas sensor according to claim 50, characterized in that said predictive control algorithm comprises an algorithm for generating said control input by determining the future value of the temperature of the exhaust gas until after the first predetermined time as being equal to the present value of the temperature of the exhaust gas.

52. A method of controlling the temperature of an exhaust gas sensor according to any one of claims 41, 44, 46, 47, and 49, characterized in that the input compo-

ment depending on said target temperature, included in said control input, comprises an input component depending on time-series data of the target temperature including a present value of the target temperature and a future value of the target temperature after a second predetermined time, and said control input including said input component is generated according to a predictive control algorithm.

53. A method of controlling the temperature of an exhaust gas sensor according to any one of claims 39 through 49, characterized in that said control input is generated according to an optimum control algorithm.

54. A method of controlling the temperature of an exhaust gas sensor according to claim 50, characterized in that said control input is generated according to an optimum predictive control algorithm.

55. A method of controlling the temperature of an exhaust gas sensor according to claim 52, characterized in that said control input is generated according to an optimum predictive control algorithm.

56. A method of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising the steps of:



sequentially acquiring element temperature data representing the temperature of said active element and heater temperature data representing the temperature of said heater, sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the heater represented by said heater temperature data to a predetermined target temperature, and controlling the heater depending on the control input, and characterized in that when said control input is generated, said control input is generated so as to include at least an input component depending on the difference between the temperature of the heater represented by said heater temperature data and said target temperature, and an input component depending on the temperature of the active element represented by said element temperature data.

57. A method of controlling the temperature of an exhaust gas sensor according to claim 56, further characterized by comprising the step of sequentially acquiring exhaust gas temperature data representing the temperature of said exhaust gas, wherein when said control input is generated, said control input is generated so as to further include an input component depending on the temperature of the exhaust gas represented by said exhaust gas temperature data.

58. A method of controlling the temperature of an exhaust gas sensor according to claim 56, characterized in that when said control input is generated, said control input is generated so as to further include an input component depending on said target temperature.

59. A method of controlling the temperature of an exhaust gas sensor according to claim 56, characterized in that said control input is generated, said control input is generated so as to further include an input component depending on the temperature of the heater represented by said heater temperature data.

60. A method of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising the steps of:

sequentially acquiring heater temperature data representing the temperature of said heater and exhaust gas temperature data representing the temperature of said exhaust gas, sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the heater represented by said heater temperature data to a predetermined target temperature, and controlling the heater depending on the control input, and characterized in that

when said control input is generated, said control input is generated so as to include at least an input component depending on the difference between the temperature of the heater represented by said heater temperature data and said target temperature, and an input component depending on the temperature of the temperature of the exhaust gas represented by said exhaust gas temperature data.

61. A method of controlling the temperature of an exhaust gas sensor according to claim 60, characterized in that when said control input is generated, said control input is generated so as to further include an input component depending on said target temperature.

62. A method of controlling the temperature of an exhaust gas sensor according to claim 60, characterized in that said control input is generated, said control input is generated so as to further include an input component depending on the temperature of the heater represented by said heater temperature data.

63. A method of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising the steps of:

sequentially acquiring heater temperature data representing the temperature of said heater, sequentially

generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the heater represented by said heater temperature data to a predetermined target temperature, and controlling the heater depending on the control input, and characterized in that when said control input is generated, said control input is generated so as to include at least an input component depending on the difference between the temperature of the heater represented by said heater temperature data and said target temperature and an input component depending on said target temperature.

64. A method of controlling the temperature of an exhaust gas sensor according to claim 63, characterized in that said control input is generated, said control input is generated so as to further include an input component depending on the temperature of the heater represented by said heater temperature data.

65. A method of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising the steps of:

sequentially acquiring heater temperature data representing the temperature of said heater, sequentially generating a control input which defines an amount of heat

generating energy supplied to said heater so as to equalize the temperature of the heater represented by said heater temperature data to a predetermined target temperature, and controlling the heater depending on the control input, and characterized in that when said control input is generated, said control input is generated so as to include at least an input component depending on the difference between the temperature of the heater represented by said heater temperature data and said target temperature and an input component depending on the temperature of said heater.

66. A method of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized by comprising the steps of:

sequentially acquiring element temperature data representing the temperature of said active element, heater temperature data representing the temperature of said heater, and exhaust gas temperature data representing the temperature of said exhaust gas, sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the heater represented by said heater temperature data to a predetermined target temperature, and controlling the heater depending on the control input, and

characterized in that when said control input is generated, said control input is generated so as to include at least an input component depending on the difference between the temperature of the heater represented by said heater temperature data and said target temperature, an input component depending on the temperature of the active element represented by said element temperature data, an input component depending on the temperature of the exhaust gas represented by said exhaust gas temperature data, and an input component depending on said target temperature.

67. A method of controlling the temperature of an exhaust gas sensor according to any one of claims 57, 60 through 62, and 66, characterized in that the input component depending on the temperature of said exhaust gas, included in said the control input, comprises an input component depending on time-series data of the temperature of the exhaust gas including a present value of the temperature of the exhaust gas and a future value of the temperature of the exhaust gas after a first predetermined time, and said control input including said input component is generated according to a predictive control algorithm.

68. A method of controlling the temperature of an exhaust gas sensor according to claim 67, characterized in that said predictive control algorithm comprises an algorithm for generating said control input by determining the future value of the temperature of the exhaust gas un-

til after the first predetermined time as being equal to the present value of the temperature of the exhaust gas.

69. A method of controlling the temperature of an exhaust gas sensor according to any one of claims 58, 61, 63, 64, and 66, characterized in that the input component depending on said target temperature, included in said control input, comprises an input component depending on time-series data of the target temperature including a present value of the target temperature and a future value of the target temperature after a second predetermined time, and said control input including said input component is generated according to a predictive control algorithm.

70. A method of controlling the temperature of an exhaust gas sensor according to any one of claims 56 through 66, characterized in that said control input is generated according to an optimum control algorithm.

71. A method of controlling the temperature of an exhaust gas sensor according to claim 67, characterized in that said control input is generated according to an optimum predictive control algorithm.

72. A method of controlling the temperature of an exhaust gas sensor according to claim 69, characterized in that said control input is generated according to an optimum predictive control algorithm.

73. A method of controlling the temperature of an exhaust gas sensor according to any one of claims 39,

43, 46, 48, 49, 56, 60, 63, 65, and 66, characterized in that said target temperature in a period immediately after said internal combustion engine has started to operate until a third predetermined time elapses is set to a temperature which is lower than said target temperature after elapse of said period immediately after said internal combustion engine has started to operate.

74. A method of controlling the temperature of an exhaust gas sensor according to claim 52, characterized in that said target temperature in a period immediately after said internal combustion engine has started to operate until a third predetermined time elapses is set to a temperature which is lower than said target temperature after elapse of said period immediately after said internal combustion engine has started to operate.

75. A method of controlling the temperature of an exhaust gas sensor according to claim 69, characterized in that said target temperature in a period immediately after said internal combustion engine has started to operate until a third predetermined time elapses is set to a temperature which is lower than said target temperature after elapse of said period immediately after said internal combustion engine has started to operate.

76. A method of controlling the temperature of an exhaust gas sensor according to any one of claims 39, 43, 46, 48, 49, 56, 60, 63, 65, and 66, characterized in



that said heater comprises an electric heater for generating heat when energized by a battery according to a pulse width control (PWM control) process, and the control input which is generated comprises a duty cycle in said pulse width control process, further characterized by comprising the step of correcting said duty cycle depending on the voltage of said battery.

77. A recording medium readable by a computer and storing a temperature control program for enabling the computer to perform a process of controlling the temperature of an active element of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having the active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized in that

said temperature control program includes a program for enabling said computer to perform a process of sequentially acquiring element temperature data representing the temperature of said active element and heater temperature data representing the temperature of said heater, a control input generating program for enabling said computer to perform a process of sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the active element represented by said element temperature data to a predetermined target temperature, and a pro-

gram for enabling said computer to perform a process of controlling the heater depending on the control input, wherein said control input generating program has an algorithm for enabling said computer to generate said control input so as to include at least an input component depending on the difference between the temperature of the active element represented by said element temperature data and said target temperature and an input component depending on the temperature of the heater represented by said heater temperature data.

78. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 77, characterized in that said temperature control program further includes a program for enabling said computer to perform a process of sequentially acquiring exhaust gas temperature data representing the temperature of said exhaust gas, wherein said control input generating program has an algorithm for enabling said computer to generate said control input so as to further include an input component depending on the temperature of the exhaust gas represented by said exhaust gas temperature data.

79. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 77, characterized in that said control input generating program has an algorithm for enabling said computer to

generate said control input so as to further include an input component depending on said target temperature.

80. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 77, characterized in that said control input generating program has an algorithm for enabling said computer to generate said control input so as to further include an input component depending on the temperature of the active element represented by said element temperature data.

81. A recording medium readable by a computer and storing a temperature control program for enabling the computer to perform a process of controlling the temperature of an active element of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having the active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized in that

said temperature control program includes a program for enabling said computer to perform a process of sequentially acquiring element temperature data representing the temperature of said active element and exhaust gas temperature data representing the temperature of said exhaust gas, a control input generating program for enabling said computer to perform a process of sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the tem-

perature of the active element represented by said element temperature data to a predetermined target temperature, and a program for enabling said computer to perform a process of controlling the heater depending on the control input, wherein said control input generating program has an algorithm for enabling said computer to generate said control input so as to include at least an input component depending on the difference between the temperature of the active element represented by said element temperature data and said target temperature and an input component depending on the temperature of the exhaust gas represented by said exhaust gas temperature data.

82. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 81, characterized in that said control input generating program has an algorithm for enabling said computer to generate said control input so as to further include an input component depending on said target temperature.

83. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 81, characterized in that said control input generating program has an algorithm for enabling said computer to generate said control input so as to further include an input component depending on the temperature of the active element represented by said element temperature data.

84. A recording medium readable by a computer and storing a temperature control program for enabling the computer to perform a process of controlling the temperature of an active element of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having the active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized in that

said temperature control program includes a program for enabling said computer to perform a process of sequentially acquiring element temperature data representing the temperature of said active element, a control input generating program for enabling said computer to perform a process of sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the active element represented by said element temperature data to a predetermined target temperature, and a program for enabling said computer to perform a process of controlling the heater depending on the control input, wherein said control input generating program has an algorithm for enabling said computer to generate said control input so as to include at least an input component depending on the difference between the temperature of the active element represented by said element temperature data and said target temperature

and an input component depending on said target temperature.

85. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 84, characterized in that said control input generating program has an algorithm for enabling said computer to generate said control input so as to further include an input component depending on the temperature of the active element represented by said element temperature data.

86. A recording medium readable by a computer and storing a temperature control program for enabling the computer to perform a process of controlling the temperature of an active element of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having the active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized in that

said temperature control program includes a program for enabling said computer to perform a process of sequentially acquiring element temperature data representing the temperature of said active element, a control input generating program for enabling said computer to perform a process of sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the active element represented by said element temperature data to a

predetermined target temperature, and a program for enabling said computer to perform a process of controlling the heater depending on the control input, wherein said control input generating program has an algorithm for enabling said computer to generate said control input so as to include at least an input component depending on the difference between the temperature of the active element represented by said element temperature data and said target temperature and an input component depending on said the temperature of the active element.

87. A recording medium readable by a computer and storing a temperature control program for enabling the computer to perform a process of controlling the temperature of an active element of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having the active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized in that

said temperature control program includes a program for enabling said computer to perform a process of sequentially acquiring element temperature data representing the temperature of said active element, heater temperature data representing the temperature of said heater, and exhaust gas temperature data representing the temperature of said exhaust gas, a control input generating program for enabling said computer to perform a process of sequentially

generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the active element represented by said element temperature data to a predetermined target temperature, and a program for enabling said computer to perform a process of controlling the heater depending on the control input, wherein said control input generating program has an algorithm for enabling said computer to generate said control input so as to include at least an input component depending on the difference between the temperature of the active element represented by said element temperature data and said target temperature, an input component depending on the temperature of the heater represented by said heater temperature data, an input component depending on the temperature of the exhaust gas represented by said exhaust gas temperature data, and an input component depending on said target temperature.

88. A recording medium storing a temperature control program for an exhaust gas sensor according to any one of claims 78, 81 through 83, and 87 characterized in that the input component depending on the temperature of said exhaust gas, included in said the control input, comprises an input component depending on time-series data of the temperature of the exhaust gas including a present value of the temperature of the exhaust gas and a future value of the temperature of the exhaust gas after a first



predetermined time, wherein said control input generating program for enabling said computer to generate said control input including said input component has a predictive control algorithm.

89. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 88, characterized in that the algorithm of said control input generating program enables said computer to generate said control input by determining the future value of the temperature of the exhaust gas until after the first predetermined time as being equal to the present value of the temperature of the exhaust gas.

90. A recording medium storing a temperature control program for an exhaust gas sensor according to any one of claims 79, 82, 84, 85, and 87, characterized in that the input component depending on said target temperature, included in said control input, comprises an input component depending on time-series data of the target temperature including a present value of the target temperature and a future value of the target temperature after a second predetermined time, wherein said control input generating program for enabling said computer to generate said control input including said input component has a predictive control algorithm.

91. A recording medium storing a temperature control program for an exhaust gas sensor according to any

one of claims 77 through 87, characterized in that the algorithm of said control input generating program comprises an optimum control algorithm.

92. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 88, characterized in that the algorithm of said control input generating program comprises an optimum predictive control algorithm.

93. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 90, characterized in that the algorithm of said control input generating program comprises an optimum predictive control algorithm.

94. A recording medium readable by a computer and storing a temperature control program for enabling the computer to perform a process of controlling the temperature of an active element of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having the active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized in that

said temperature control program includes a program for enabling said computer to perform a process of sequentially acquiring element temperature data representing the temperature of said active element and heater temperature data representing the temperature of said heater, a

control input generating program for enabling said computer to perform a process of sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the heater represented by said heater temperature data to a predetermined target temperature, and a program for enabling said computer to perform a process of controlling the heater depending on the control input, wherein said control input generating program has an algorithm for enabling said computer to generate said control input so as to include at least an input component depending on the difference between the temperature of the heater represented by said heater temperature data and said target temperature, and an input component depending on the temperature of the active element represented by said element temperature data.

95. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 94, characterized in that said temperature control program further includes a program for enabling said computer to perform a process of sequentially acquiring exhaust gas temperature data representing the temperature of said exhaust gas, wherein said control input generating program has an algorithm for enabling said computer to generate said control input so as to further include an input

component depending on the temperature of the exhaust gas represented by said exhaust gas temperature data.

96. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 94, characterized in that said control input generating program has an algorithm for enabling said computer to generate said control input so as to further include an input component depending on said target temperature.

97. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 94, characterized in that said control input generating program has an algorithm for enabling said computer to generate said control input so as to further include an input component depending on the temperature of the heater represented by said heater temperature data.

98. A recording medium readable by a computer and storing a temperature control program for enabling the computer to perform a process of controlling the temperature of an active element of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having the active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized in that

said temperature control program includes a program for enabling said computer to perform a process of sequentially acquiring heater temperature data representing

the temperature of said heater and exhaust gas temperature data representing the temperature of said exhaust gas, a control input generating program for enabling said computer to perform a process of sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the heater represented by said heater temperature data to a predetermined target temperature, and a program for enabling said computer to perform a process of controlling the heater depending on the control input, wherein said control input generating program has an algorithm for enabling said computer to generate said control input so as to include at least an input component depending on the difference between the temperature of the heater represented by said heater temperature data and said target temperature and an input component depending on the temperature of the exhaust gas represented by said exhaust gas temperature data.

99. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 98, characterized in that said control input generating program has an algorithm for enabling said computer to generate said control input so as to further include an input component depending on said target temperature.

100. A recording medium storing a temperature control program for an exhaust gas sensor according to

claim 98, characterized in that said control input generating program has an algorithm for enabling said computer to generate said control input so as to further include an input component depending on the temperature of the heater represented by said heater temperature data.

101. A recording medium readable by a computer and storing a temperature control program for enabling the computer to perform a process of controlling the temperature of an active element of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having the active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized in that

said temperature control program includes a program for enabling said computer to perform a process of sequentially acquiring heater temperature data representing the temperature of said heater, a control input generating program for enabling said computer to perform a process of sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the heater represented by said heater temperature data to a predetermined target temperature, and a program for enabling said computer to perform a process of controlling the heater depending on the control input, wherein said control input generating program has an algorithm for enabling said computer to gener-

ate said control input so as to include at least an input component depending on the difference between the temperature of the heater represented by said heater temperature data and said target temperature and an input component depending on said target temperature.

102. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 101, characterized in that said control input generating program has an algorithm for enabling said computer to generate said control input so as to further include an input component depending on the temperature of the heater represented by said heater temperature data.

103. A recording medium readable by a computer and storing a temperature control program for enabling the computer to perform a process of controlling the temperature of an active element of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having the active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized in that

said temperature control program includes a program for enabling said computer to perform a process of sequentially acquiring heater temperature data representing the temperature of said heater, a control input generating program for enabling said computer to perform a process of sequentially generating a control input which defines an

amount of heat generating energy supplied to said heater so as to equalize the temperature of the heater represented by said heater temperature data to a predetermined target temperature, and a program for enabling said computer to perform a process of controlling the heater depending on the control input, wherein said control input generating program has an algorithm for enabling said computer to generate said control input so as to include at least an input component depending on the difference between the temperature of the heater represented by said heater temperature data and said target temperature and an input component depending on the temperature of said heater.

104. A recording medium readable by a computer and storing a temperature control program for enabling the computer to perform a process of controlling the temperature of an active element of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having the active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, characterized in that

said temperature control program includes a program for enabling said computer to perform a process of sequentially acquiring element temperature data representing the temperature of said active element, heater temperature data representing the temperature of said heater, and exhaust gas temperature data representing the temperature of



said exhaust gas, a control input generating program for enabling said computer to perform a process of sequentially generating a control input which defines an amount of heat generating energy supplied to said heater so as to equalize the temperature of the heater represented by said heater temperature data to a predetermined target temperature, and a program for enabling said computer to perform a process of controlling the heater depending on the control input, wherein said control input generating program has an algorithm for enabling said computer to generate said control input so as to include at least an input component depending on the difference between the temperature of the heater represented by said heater temperature data and said target temperature, an input component depending on the temperature of the active element represented by said element temperature data, an input component depending on the temperature of the exhaust gas represented by said exhaust gas temperature data, and an input component depending on said target temperature.

105. A recording medium storing a temperature control program for an exhaust gas sensor according to any one of claims 95, 98 through 100, and 104 characterized in that the input component depending on the temperature of said exhaust gas, included in said the control input, comprises an input component depending on time-series data of the temperature of the exhaust gas including a present

value of the temperature of the exhaust gas and a future value of the temperature of the exhaust gas after a first predetermined time, wherein said control input generating program for enabling said computer to generate said control input including said input component has a predictive control algorithm.

106. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 105, characterized in that the algorithm of said control input generating program enables said computer to generate said control input by determining the future value of the temperature of the exhaust gas until after the first predetermined time as being equal to the present value of the temperature of the exhaust gas.

107. A recording medium storing a temperature control program for an exhaust gas sensor according to any one of claims 96, 99, 101, 102, and 104, characterized in that the input component depending on said target temperature, included in said control input, comprises an input component depending on time-series data of the target temperature including a present value of the target temperature and a future value of the target temperature after a second predetermined time, wherein said control input generating program for enabling said computer to generate said control input including said input component has a predictive control algorithm.

108. A recording medium storing a temperature control program for an exhaust gas sensor according to any one of claims 94 through 104, characterized in that the algorithm of said control input generating program comprises an optimum control algorithm.

109. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 105, characterized in that the algorithm of said control input generating program comprises an optimum control algorithm.

110. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 107, characterized in that the algorithm of said control input generating program comprises an optimum control algorithm.

111. A recording medium storing a temperature control program for an exhaust gas sensor according to any one of claims 77, 81, 84, 86, 87, 94, 98, 101, 103, and 104, characterized in that said control input generating program has an algorithm for setting said target temperature in a period immediately after said internal combustion engine has started to operate until a third predetermined time elapses, to a temperature which is lower than said target temperature after elapse of said period immediately after said internal combustion engine has started to operate.

112. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 90, characterized in that said control input generating program has an algorithm for setting said target temperature in a period immediately after said internal combustion engine has started to operate until a third predetermined time elapses, to a temperature which is lower than said target temperature after elapse of said period immediately after said internal combustion engine has started to operate.

113. A recording medium storing a temperature control program for an exhaust gas sensor according to claim 107, characterized in that said control input generating program has an algorithm for setting said target temperature in a period immediately after said internal combustion engine has started to operate until a third predetermined time elapses, to a temperature which is lower than said target temperature after elapse of said period immediately after said internal combustion engine has started to operate.

114. A recording medium storing a temperature control program for an exhaust gas sensor according to any one of claims 77, 81, 84, 86, 87, 94, 98, 101, 103, and 104, characterized in that said heater comprises an electric heater for generating heat when energized by a battery according to a pulse width control (PWM control) process,

and the control input which is generated by said computer according to said control input program comprises a duty cycle in said pulse width control process, wherein said temperature control program further includes a program for enabling said computer to perform a process of correcting said duty cycle generated by said control input generating program depending on the voltage of said battery.